

Shadowing Effects on the Nuclear Suppression Factor, R_{dAu} , in d+Au Interactions

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One of the most intriguing results from the Relativistic Heavy Ion Collider (RHIC) has been the suppression of high transverse momentum, p_T , hadrons, in central Au+Au collisions, quantified as R_{AA} . Saturation effects in the initial nuclear wave function and final-state parton energy loss were both proposed as explanations. To find the answer, d+Au collisions at $\sqrt{S_{NN}} = 200$ GeV were recently studied at RHIC. The data show that, at $\eta \approx 0$, the d+Au suppression factor,

$$R_{\text{dAu}}(p_T) = \frac{d\sigma_{\text{dAu}}/dp_T}{\langle \sigma_{NN}^{\text{in}} T_{\text{dAu}} \rangle d\sigma_{pp}/dp_T}, \quad (1)$$

is much closer to unity. These results suggest that saturation effects on R_{AA} are small. However, at higher rapidities where the nuclear parton momentum fraction, x_2 , is smaller, such effects might still be important. Since x is not very small at RHIC, it is necessary to check whether nuclear shadowing may also explain the data.

The BRAHMS collaboration has measured R_{dAu} at several values of pseudorapidity, η , and observed increasing suppression as η increases from $|\eta| \leq 0.2$ to $\eta = 3.2$ [1]. These data have also been divided into three centrality bins: (0 – 20)%, (30 – 50)% and (60 – 80)% of the geometric cross section. The central-to-peripheral ratio, R_{CP} , also decreases with increasing rapidity.

We calculate $R_{\text{dAu}}(p_T)$ and $R_{\text{CP}}(p_T)$ in the BRAHMS η bins using two parameterizations of nuclear shadowing [2] and compare to the BRAHMS data [1]. To illustrate the shadowing effects, we do not include p_T broadening.

We make a leading order (LO) calculation of minijet production to obtain the yield of high- p_T partons. We have chosen two parameterizations of nuclear shadowing which cover extremes of gluon shadowing at low x . The Eskola *et al.* parameterization, EKS98, and the parameterizations by Frankfurt, Guzey and Strikman (FGS).

We compare the FGS ratios, R_{dAu} , to the BRAHMS data [1] in Fig. 1. We show the results for charged pions (dashed), charged kaons (dot-dashed) and protons/antiprotons (dotted) separately. The solid curves give the total charged hadron result. At midrapidity, where $\langle x_2 \rangle$ is relatively large, the two parameterizations give rather similar results. The difference between the kaon and proton ratios is due to isospin. While pion production is dominated by gluons, it is essentially isospin independent. The ratio is greater than unity but smaller than the BRAHMS result at midrapidity.

At $\eta = 1$ and low p_T , the ratio is less than unity. At $p_T \sim 2.5$ GeV, R_{dAu} rises above unity again. At higher rapidities, R_{dAu} decreases at low p_T but does not rise as far above unity at higher p_T until, at $\eta = 3.2$, the

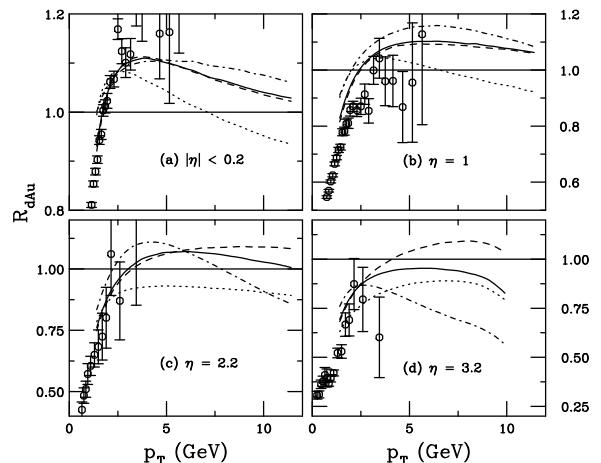


FIG. 1: R_{dAu} for charged pions (dashed) and kaons (dot-dashed) as well as protons and antiprotons (dotted) and the sum (solid) for d+Au collisions at $\sqrt{S_{NN}} = 200$ GeV as a function of p_T . The results with the FGS parameterization are compared to the minimum bias BRAHMS data for: (a) $|\eta| \leq 0.2$; (b) $\eta = 1$; (c) $\eta = 2.2$ and (d) $\eta = 3.2$.

total charged hadron ratio is less than unity for all p_T . The FGS parameterization agrees rather well with the central η data, Fig. 1(a), and lies within the errors of the most peripheral bins for $p_T > \sqrt{2}$ GeV, Fig. 1(c) and (d). However, the total charged hadron data at $\eta = 1$ are somewhat underestimated, Fig. 1(b). At large p_T , the calculations are dominated by isospin.

In the most central bins, the ratio for the total charged hadrons closely follows R_{dAu} for the pions. At higher η , the kaon contribution becomes more important, causing the total to be closer to the average of the pion and kaon results. The proton contribution, on the other hand, remains small, even at $\eta = 3.2$, while one may expect that proton production would be more important.

The suppression factor, R_{dAu} , calculated with leading-twist FGS shadowing, agrees moderately well with the BRAHMS data. Thus saturation effects may not dominate the forward region at RHIC. Our calculations of R_{CP} have a stronger p_T dependence than the data, likely due to insufficient understanding of the impact parameter dependence of shadowing.

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